Investigating the reprocessing of mine tailings

- Experiences from the research project “REWITA”

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Presentation outline

- Project introduction
- Deposit & material characterization
- Motivation & potential benefits
- Consequences for the process development
- Mineral processing approach
- Conclusion & outlook
Project introduction - tailing Bolllrich

- Massive sulfide SEDEX - ore
- Hercynian mountain range, North Germany
- > 1000 years of mining at Rammelsberg \(1988\)
- Flotation 1936 - 1988
- Content approx. 7 mio. t
Project introduction - structure

Sampling and characterization
- Mineralogy
- Deposit and geomechanical aspects

Remining concept
- Adapted mining technology and techniques
- Optimized machinery

Reprocessing concept
- Investigation of mineral processing
- Metallurgy

Cooperation with local
- Companies (business model)
- Authorities (compliance)

Project accompanied by
- Economic calculations
- Ecologic calculations

Overall concept development

Images (IFAD, IBB) and adopted from [2]
Material characterization - chemical composition and mineralogy

Main compound groups

- Sulfates (24.6 %)
- Sulfides (19.3 %)
- Carbonates (22.7 %)
- Silicates (33.1 %)

Metals of interest (metal content in tailing)

- Ba (14.5 %)
- Zn (1.39 %), Pb (1.21 %), Cu (0.15 %), Fe* (12.6 %)

Trace metals of economic or strategic importance

- Ag, Au, In, Co, Sb, Ga**

Main [trace] elements with negative potential

- Pb, S, [As], [Cd], [Tl], [Sb]

Fe* = Due to AMD not value
Ga** = No clear correlation detected
Material characterization - backscattered electrons images

Backscattered electrons image (IELF)
Material characterization - deposit modelling

- Modelling of the deposit
  - Homogeneous material composition in general
  - Can be enhanced by old data
- Main deviations in chemical properties
  - Due to changes in the mineral processing chart
  - Observed for barite (increasing with depth)
- Main deviations in physical properties
  - Changes of the inlet points (irregular) and comminution
Motivation - overview

- ECONOMY
- EFFICIENCY
- ENVIRONMENT
- SAFETY
- COMMUNITY*

SUSTAINABLE MINING PRACTICES

Community*: Not discussed in this presentation. Sustainable Mining Practices adopted from [2]
Motivation - economy

- Rise in demand and prices
- New metals of interest
- Sometimes less costs for mining and milling
- Cost avoidance for maintenance and aftercare
Motivation - resource efficiency

- Decreasing metal contents in deposits
- Partially decreasing reserves
- Unused anthropogenic deposit
- Import dependency
  - Many countries like Germany without primary resources
  - Critical raw materials defined by the EU, partially found in tailings
    - In, Co, Sb, Ga
Motivation - safety & environment

- Dam failures
  - Several smaller and larger dam failures every year
  - Up-stream dams sensible to failure
  - Underground stability

- Sulfidic tailings may lead to
  - Acidification
  - Mobilization of toxic elements
    - Tl, As, Co, Cd

- Follow-up cost may be very high
Consequences for the process development at the tailing Bollrich

- **Overall goals**
  - Sanitation probably necessary (costly)
  - Residue reduction (costs for redepositing)

- **Remining**
  - Removal of the material and dam must be conducted vertically layer by layer
  - In-situ mining and deposition not possible

- **Reprocessing**
  - Barite winning (material reduction and value)
  - Concentration of harmful and valuable elements in sulfides
  - Generation of inert material

High complexity but potential costs through environmental and safety risks are very high
Mineral processing approach - overview

- Flotation
  - Mixed sulfide concentrate with dithiophosphinates / carbamates
  - Barite with anionic alkysulfate
  - Silicates/ carbonates with amines

- Hydrometallurgy
  - Different processing routes investigated
  - Most feasible selective recovery of Cu, Zn with NH₃, containment/ bioleaching of residue

- Treatment of barite and inert material necessary
Mineral processing approach - example

- Barite flotation possible
- Low enrichment/ recovery/ product quality
  - ~ 3/80 % rougher, 85 - 90 % BaSO₄ in 2. cleaner float
  - 5 - 10 % sulfide losses to float
  - Intergrowth/ particle size
- High chemical input due to particle size
  - Consumption relatively high
  - Negative impacts for subsequent flotation steps
- Further treatment may be required
  - Requirement ~ 95 %
  - BaSO₄ usually roasted (destruction of chemicals)
  - Additional leaching may be necessary

1. rougher tailing
   2 - 5 % BaSO₄

1. cleaner tailing
   50 - 60 % BaSO₄

2. cleaner float
   85 - 90 % BaSO₄

Tailings and barite float (IFAD)
Conclusions and outlook I - reprocessing

- Currently many investigations
- Reprocessing not solely value carrier driven, high complexities in decision making
- Value contents usually comparatively low, but might reach economic/strategic relevance
- Main motivation for reprocessing is still profit and, to a lesser extent, avoided costs
- Business alternative for reprocessing may be sanitation or other follow-up costs/compensations
Conclusions and outlook II - current tailing management

- Possible problems and value potentials should be monitored and anticipated
- Different residues should be separated to facilitate future separation efforts
- Externalization of follow-up costs must be prevented politically to enforce sustainable mining
  - Longlivity of structures must be considered
  - Consideration of possible long-term follow-up costs
Thank you for your attention!
References


